# APPENDIX E (continued)

Powerpoint Presentations
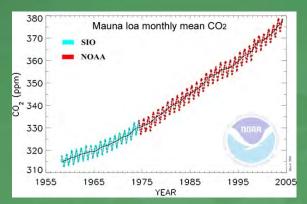
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# Global environmental changes are altering climate, biogeochemical cycles, and species composition
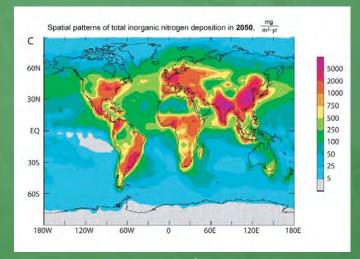


-Rising atmospheric $CO_2$



-Warming



-Shifting precipitation



-Nitrogen deposition



-Invasive species, altered fire regimes
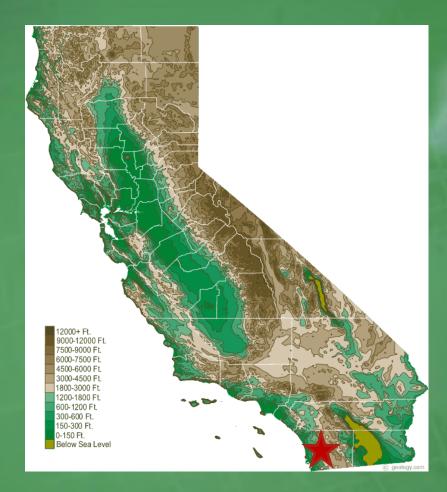
# California: a biodiversity hotspot

- California floristic province is one of the 10 most diverse areas on earth
- 2000+ endemic plant species
- San Diego County + 1500 total plant species

# Outline

- Species responses to climate change (observed/predicted)
  - Phenology
  - Range shifts (caveats)

- Coastal sage scrub
  - Case studies: checkerspot butterfly, CA gnatcatcher
  - Response of CSS vs invasive plants to altered rainfall
  - Additional factors: Fire, N deposition
  - Restoration in the face of invasion and environmental change

12000+ Ft.
9000-12000 Ft.
7500-9000 Ft.
6000-7500 Ft.
4500-6000 Ft.
3000-4500 Ft.
1800-3000 Ft.
1200-1800 Ft.
600-1200 Ft.
300-600 Ft.
150-300 Ft.
0-150 Ft.
Below Sea Level

© geology.com

# Phenology (timing) is a key component of the ecology of a species
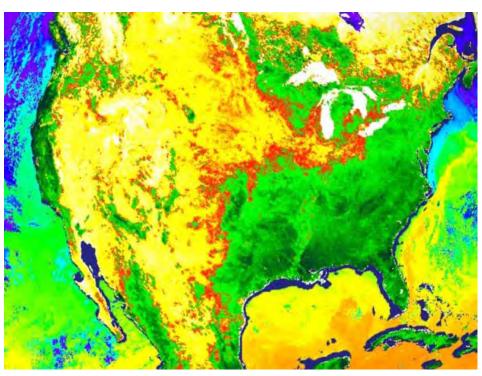
- Phenology: study of developmental events in the life of an organism

- Species are often active at different times during the growing season

- Complementary phenology enables co-existence in diverse communities

# Shifting phenology provides evidence that global change is already impacting species and ecosystems



Mark D. Schwartz



http://www.hort.wisc.edu/



http://modis.gsfc.nasa.gov/

-Are these changes in phenology predictive of species at risk of declining with future climate change?

Cleland et al. *Trends in Ecology and Evolution* 2007

# Could phenological sensitivity predict species performance responses to warming?

- Meta-analysis of warming experiments

- Paired observations of phenology and performance (biomass, seed production, etc.)

- Within and across sites
  - Is local monitoring worth it?
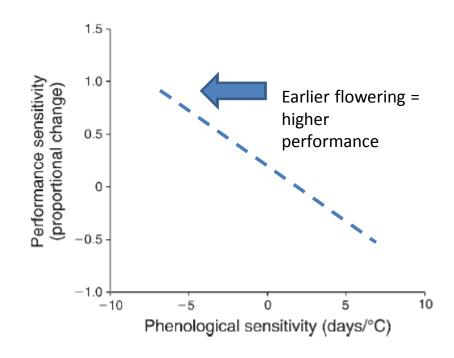


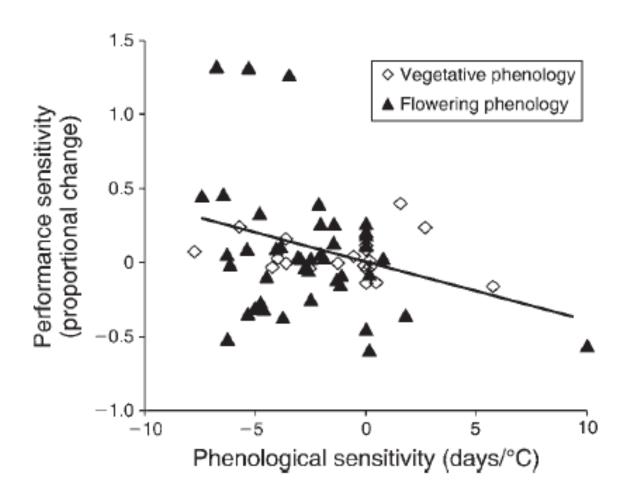Harvard Forest Soil Warming



Jasper Ridge Global Change Experiment



Open-top chamber, White Mountains CA

# Hypothesis: Species which phenologically "track" climate should maintain performance with warming

□ Most phenological sensitivities are negative (earlier flowering per ° warming)

□ We expected a negative relationship between phenological sensitivity and performance (i.e. "tracking" the thermal niche is adaptive)
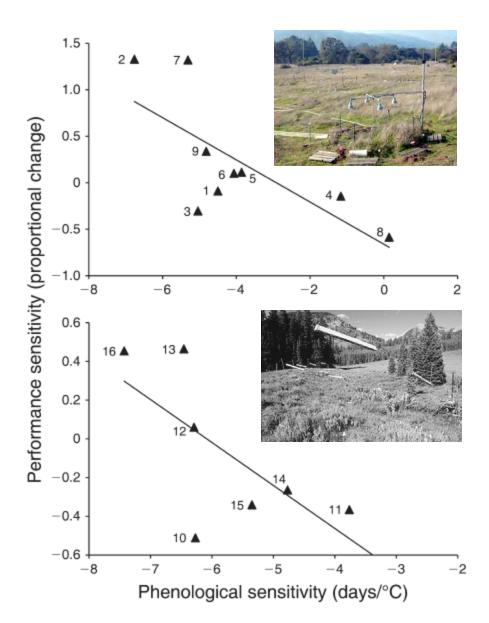


Earlier flowering = higher performance

# Across all sites: Species that "track" climate have higher performance



Cleland et al. 2012, *Ecology*

# Within sites phenological sensitvity is a better predictor of performance

- Jasper Ridge Global Change Experiment (9 species)
  - Annual grassland, in the interior foothills of coast range central California

- Rocky Mountain Biological Lab Warming Meadow (7 species)
  - Alpine meadow in Colorado

- Land managers can use phenological monitoring to identify species at risk of declining with climate change
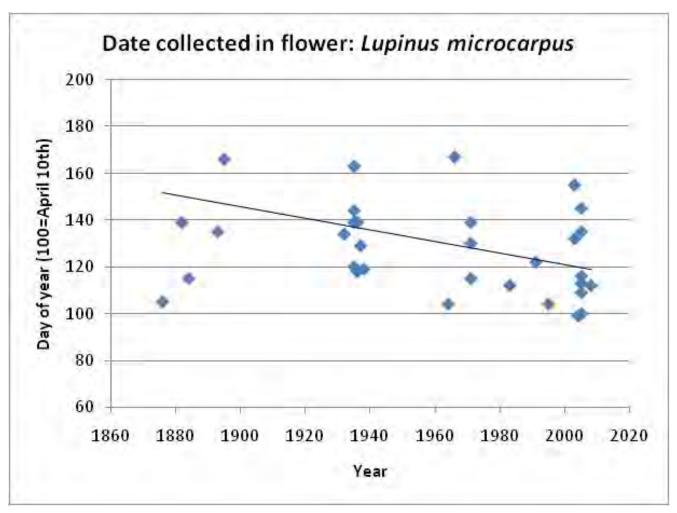
Cleland et al. 2012, *Ecology*

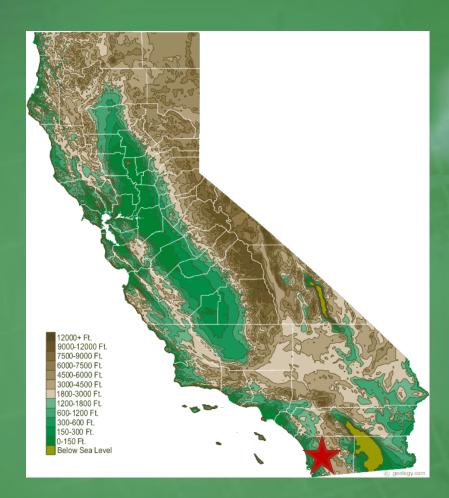# Herbarium specimens show earlier flowering in San Diego County – signal of warming?



www.calphotos.berkeley.edu

Data source: SDMNH Herbarium specimens, San Diego Plant Atlas, Mary Ann Hawke & Layla Aerne
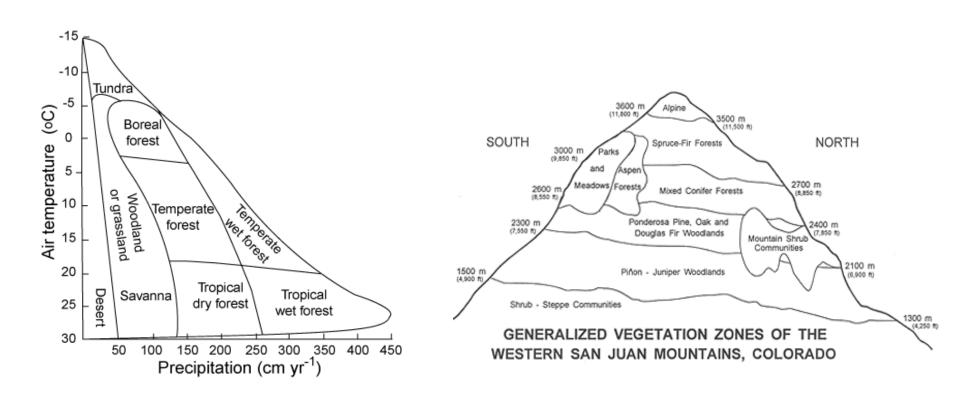
# Outline

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600-1200 Ft.
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0-150 Ft.
Below Sea Level

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Basic assumption: With increasing temperatures, we expect species to move poleward and up in elevation, also constrained by precipitation & seasonality

In recent decades, have we seen this pattern?

# Rapid shifts in plant distribution with recent climate change
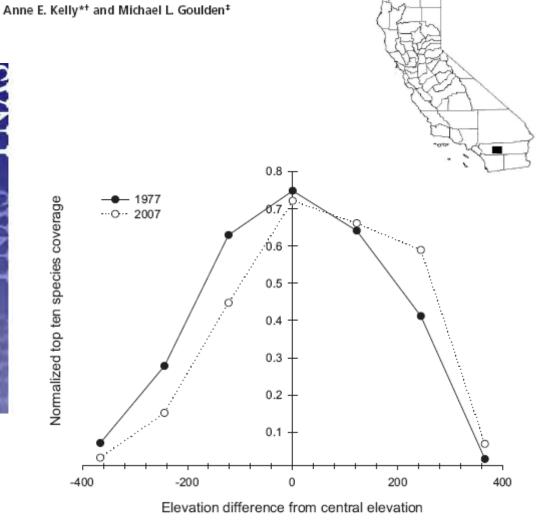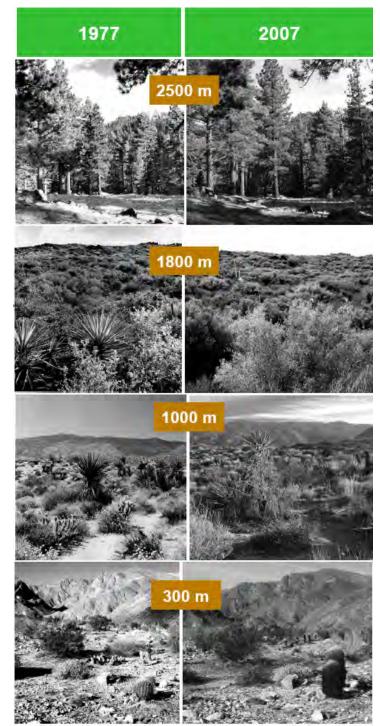
Anne E. Kelly*† and Michael L. Goulden‡

Fig. 3. Changing vegetation distribution from 1977 to 2006–2007. Elevation distribution of the mean normalized vegetation coverage of the ten most widely distributed species in 1977 and 2006–2007.

-Ex. Small mammal communities in Yosemite National Park

-2003-2006 Re-sampled areas originally monitored by Grinnell & colleagues 1914-1920

-3ºC increase in temperatures over this time
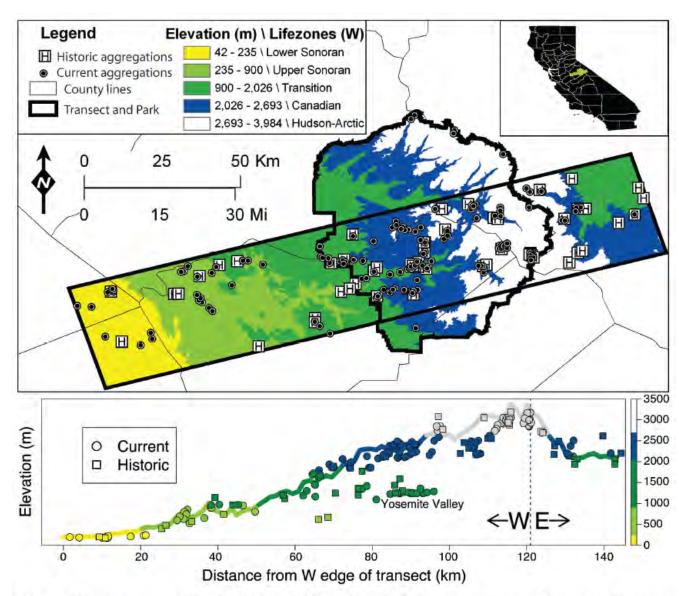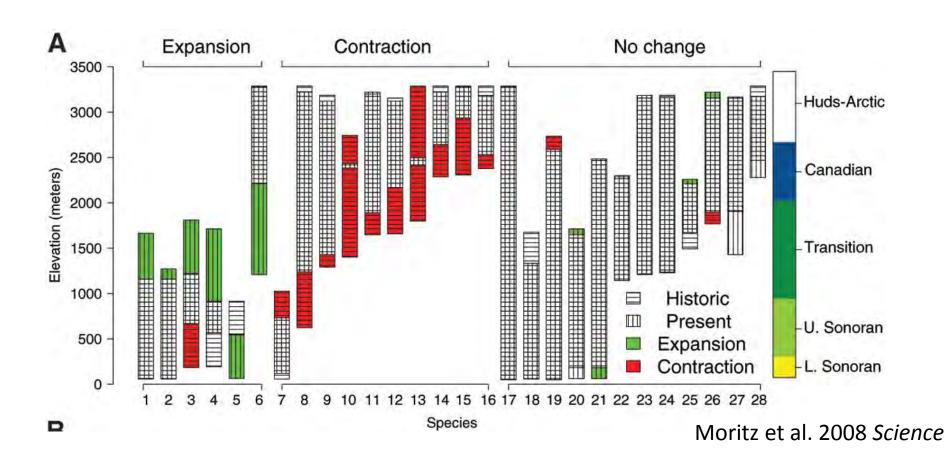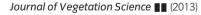


Fig. 1. Map of surveyed sites in Grinnell (Historic) and Current surveys relative to the Yosemite National Park boundary and life zones (upper panel), and to an averaged elevational profile (lower panel).

Moritz et al. 2008 *Science*

- Average increase in elevational ranges of small mammals

- Species responses were mixed, some moved down

- Much of this average shift was due to contractions at the lower edge of the elevational range



Moritz et al. 2008 *Science*
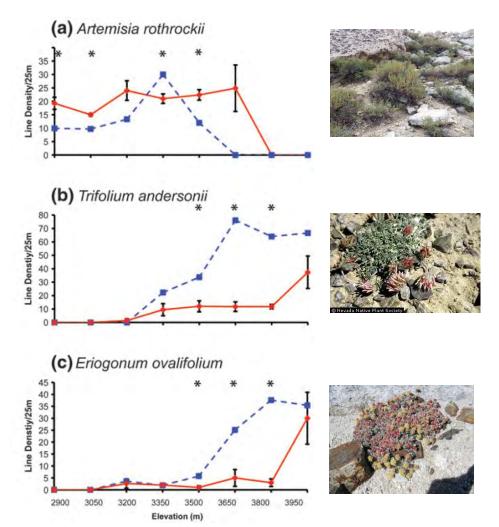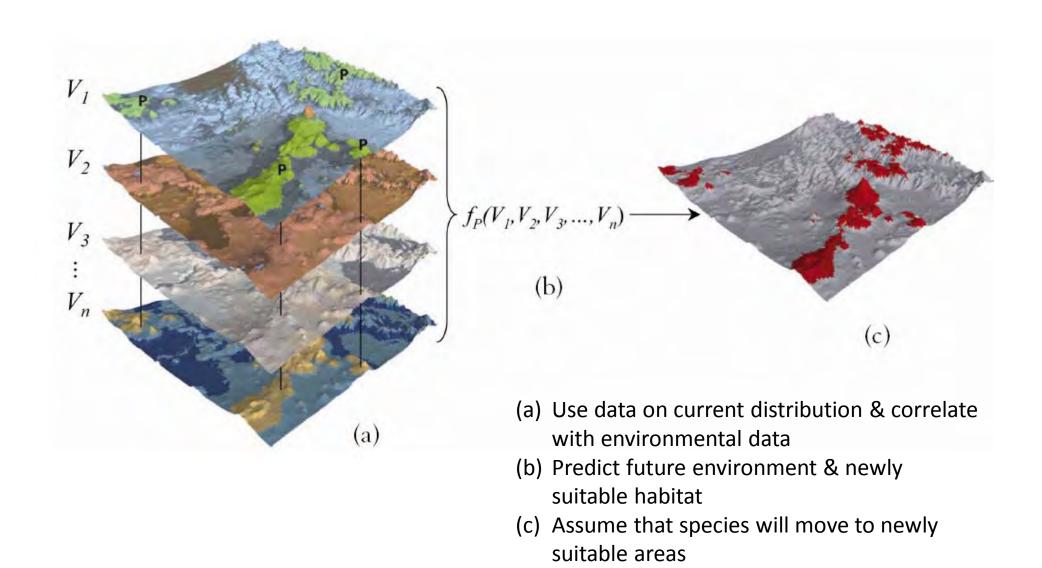
# Shifts in plant species elevational range limits and abundances observed over nearly five decades in a western North America mountain range

Christopher W. Kopp & Elsa E. Cleland



(a) *Artemisia rothrockii*

(b) *Trifolium andersonii*

(c) *Eriogonum ovalifolium*
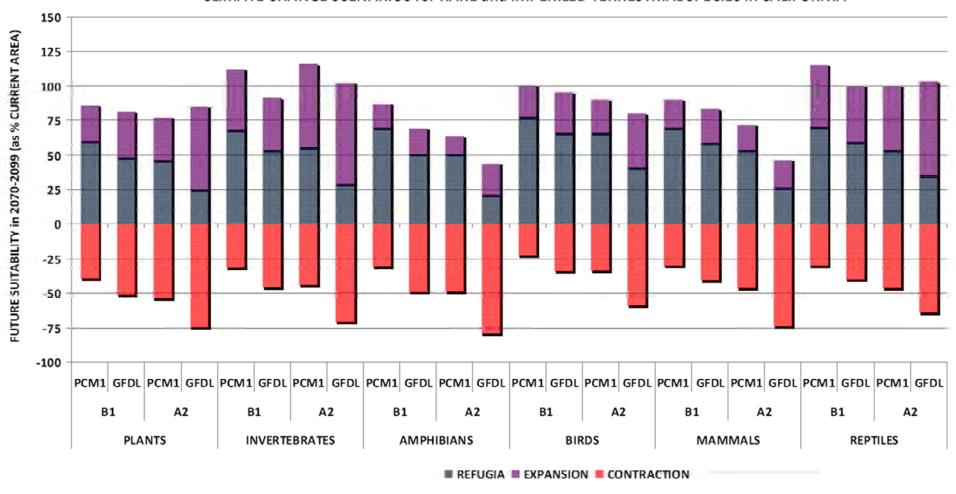
-2010 resurvey of elevational transects in the White Mountains originally collected in 1961

-Individualistic species responses in abundance and elevational range (no average shift upwards)

-Sagebrush moved rapidly upward and became much more abundant

-Sagebrush encroachment potentially contributed to large declines in cushion plants

-Conclusion: altered species interactions with climate change

# How to predict where species will move?



$$f_P(V_1, V_2, V_3, ..., V_n) \longrightarrow$$

(a)

(b)

(c)

(a) Use data on current distribution & correlate with environmental data
(b) Predict future environment & newly suitable habitat
(c) Assume that species will move to newly suitable areas

# Projected range shifts for rare species



Shaw et al 2009, California Climate Change Center Draft Report
"The Impact of Climate Change on California's Ecosystem Services"

**Caveats:Species Distribution Models (SDMs)**

-Assume a set dispersal distance
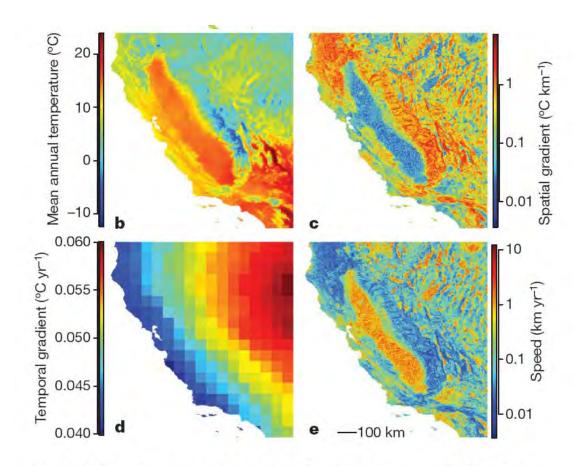
-Lots of barriers to dispersal

-Other habitat requirements (e.g. soils, biotic interactions)

-Velocity of climate change is faster for flat areas than steep elevation gradients, species need to disperse further faster in areas without elevational gradients



Figure 1 | Changing temperature in California. a, Current (1950–2000) mean annual temperature at 800 m resolution. The black rectangle indicates the Central California inset in b. c, The spatial gradient of temperature change using a 9 pixel kernel. d, The temporal gradient of climate change from 2000–2099 from 0.5 °C 16 general circulation model (GCM) ensemble projection with A1B emissions. e, The velocity of climate change determined from the quotient of d and c.

Loarie et al. 2009 Nature

-Species Distribution Models (SDMs) have become more advanced

-Ex. Network chain analysis recognizes that species will need to move across landscapes over time

-Identifies critical areas of connectivity

-Outputs of SDM predictions available



GFDL,d=1.5,t=2080,r=57

- 🟩 existing protection
- ⬛ developed
- 🟨 additional protection
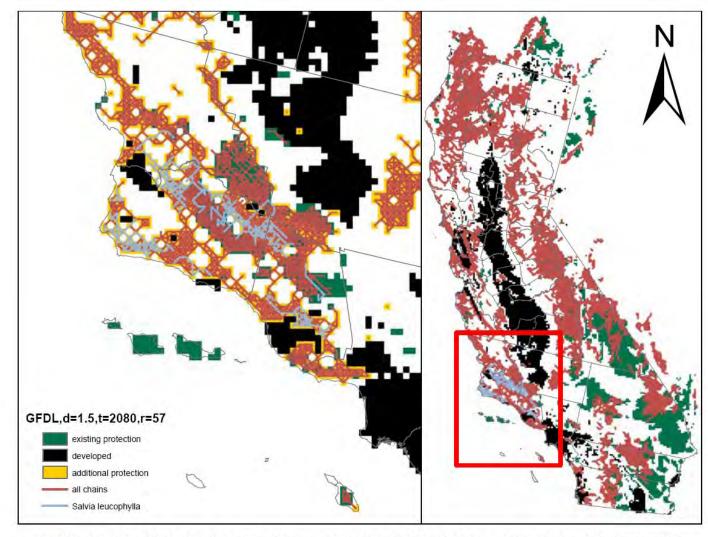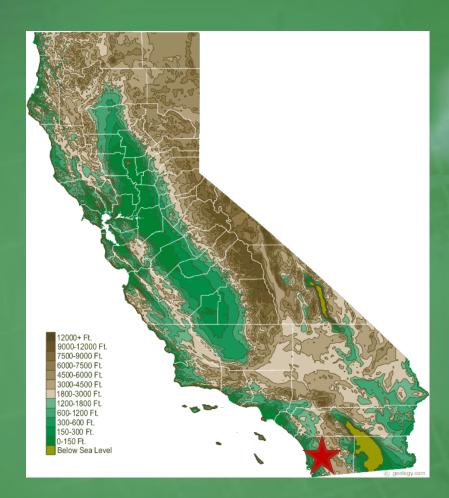- 🟥 all chains
- 🟦 Salvia leucophylla

Figure 2.9: Required Chains of *Salvia Leucophylla* (Blue) Overlaid on All Connectivity Chains Formed Under GFDL Climate Projections Through 2080. Model outputs shown assume 1.5 pixel dispersal distance and 1,000km$^2$ suitable habitat (57 chains) requirement.

Hannah et al. 2012 Consequences of climate change for native plants and conservation. CEC-500-2012-024
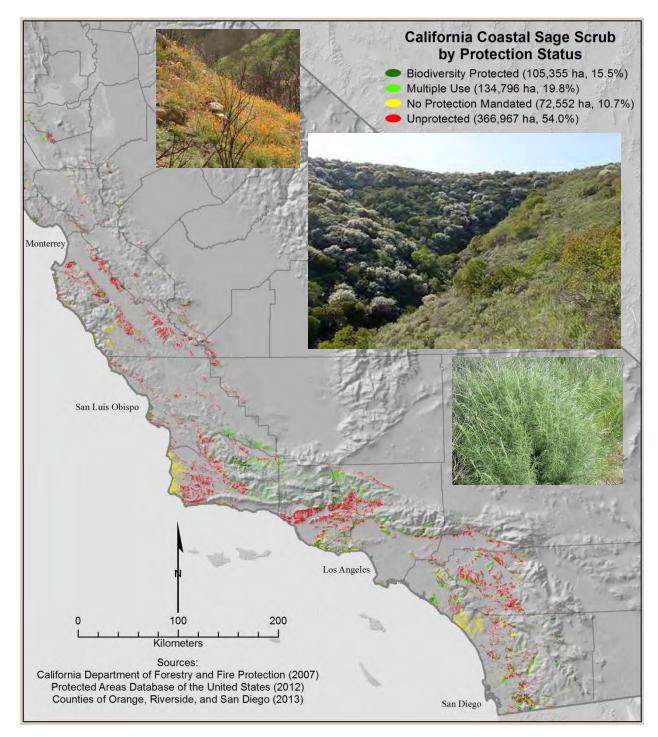
## Outline



- Species responses to climate change (observed/predicted)
  - Phenology
  - Range shifts (caveats)

- Coastal sage scrub in SD
  - Case studies: checkerspot butterfly, CA gnatcatcher
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## Coastal Sage Scrub

-One of the most endangered ecosystems in the US (Rubinoff 2001)

 - ≈ 200 species of forbs (Skinner & Pavlik 1994), many sensitive/listed under ESA

- ≈ 100 listed/sensitive animal species in Southern CA CSS, 30+ birds, 30+ mammals, 25+ herps, several inverts
(www.rctlma.org/mshcp/volume1/index.html, www.sdcounty.ca.gov/pds/mscp/biology.html).

- More than half has no protection (data from USGS 2013)



California Coastal Sage Scrub by Protection Status
- Biodiversity Protected (105,355 ha, 15.5%)
- Multiple Use (134,796 ha, 19.8%)
- No Protection Mandated (72,552 ha, 10.7%)
- Unprotected (366,967 ha, 54.0%)

Monterrey

San Luis Obispo

Los Angeles

San Diego

0    100    200
Kilometers

Sources:
California Department of Forestry and Fire Protection (2007)
Protected Areas Database of the United States (2012)
Counties of Orange, Riverside, and San Diego (2013)

# Quino checkerspot (*Euphydryas editha quino*)

Photo credit: Eric Lacoste

- Checkerspots have moved inland and up in elevation

- New populations in areas of higher rainfall, buffered from drought

- Populations most likely to go extinct were isolated, had a history of grazing/disturbance, near the coast

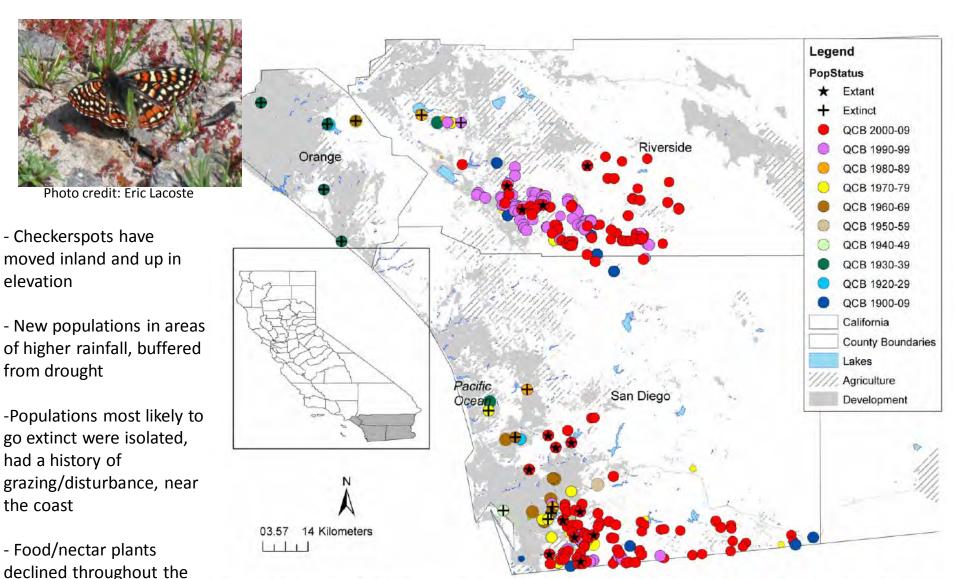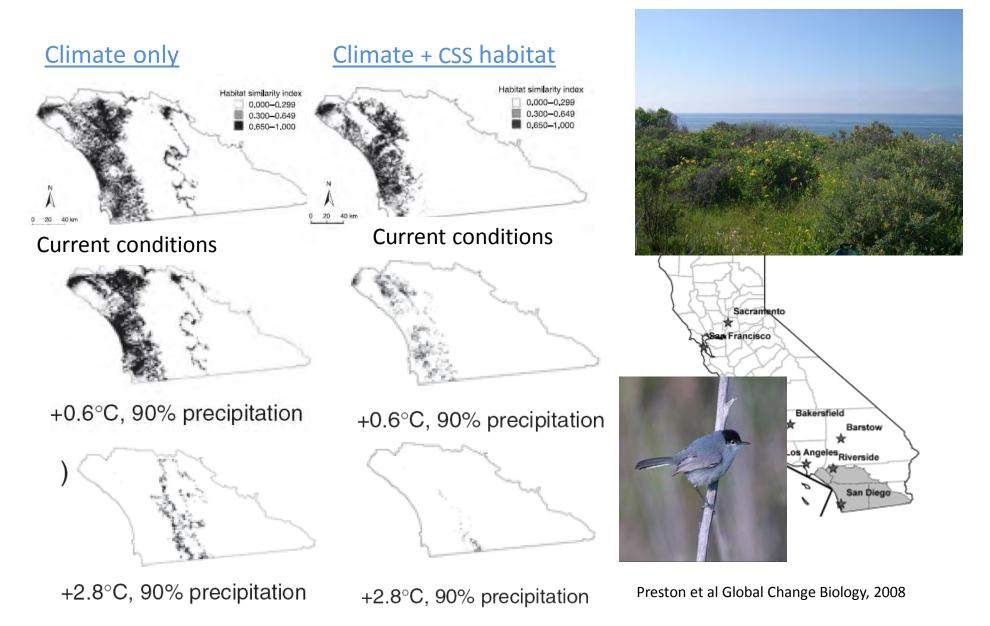- Food/nectar plants declined throughout the range, competition with invasive plants



Fig. 1. Quino checkerspot butterfly (QCB) study area and butterfly locations classified by colored circles according to the most recent decade in which an observation was reported. Also shown are locations of extinct (triangle) and extant (circle) populations used in modeling.
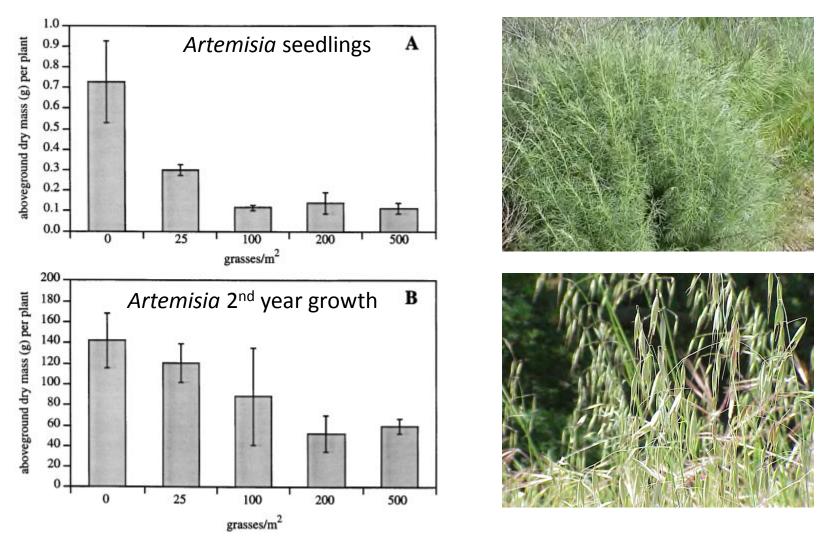
Preston et al. 2012 *Biological Conservation*

# California gnatcatcher response to climate change depends on CSS range shift



Climate only

Climate + CSS habitat

Current conditions

Current conditions

+0.6°C, 90% precipitation

+0.6°C, 90% precipitation

+2.8°C, 90% precipitation

+2.8°C, 90% precipitation
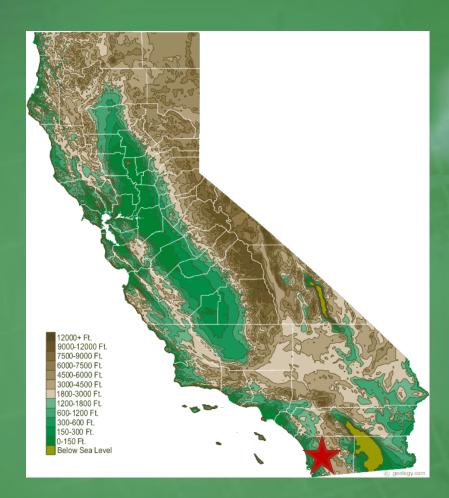
Preston et al Global Change Biology, 2008

# Climate change adaptation for many sensitive species will depend on reducing invasion by exotic annual grasses, which prevent establishment & growth by native CSS shrubs
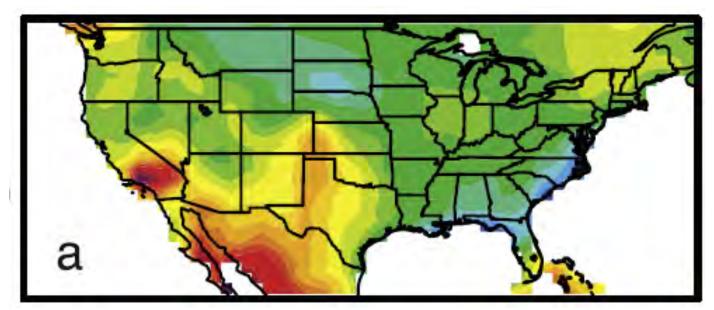


Eliason & Allen 1997, *Restoration Ecology*

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600-1200 Ft.
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150-300 Ft.
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Below Sea Level

© geology.com

# How will native CSS compete with exotic species with predicted climate change?



Diffenbaugh *et al.* 2008

- Coming decades are predicted to be warmer & drier

- Greater inter-annual variability in temperature & precipitation (extreme wet years and dry years)

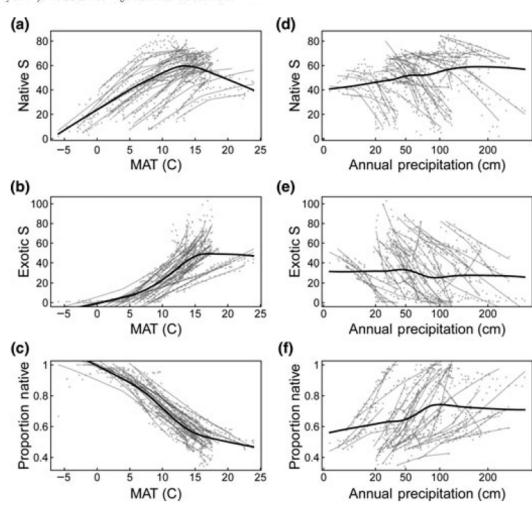# Climate change and the invasion of California by grasses

BRODY SANDEL and EMILY M. DANGREMOND

*Department of Integrative Biology, University of California, Berkeley, CA 94720, USA*

-Exotic species are currently found in warmer areas of California

-Exotic annual grasses are particularly likely to have traits associated with warm areas

-Predict exotic annual grasses will increase in abundance and extent with future warming

-Patterns with rainfall are much less clear

# Do high rainfall years (or supplemental water) promote native shrub restoration?

- In past decades, waves of shrub establishment correspond with El Niño years

- Exotic annual species also often have high biomass under high resource supply

- Response of native shrubs to high rainfall may depend on competition with exotic species

# Rainfall manipulation experiments

- UC Elliott Chaparral Reserve (MCAS Miramar), Santa Margarita Ecological Reserve (Fallbrook)

- Collect and reapply rainfall (drought to deluge)

- 3.5 x 3.5 m plots

- Measures:
  - Mature shrub growth
  - Growth and establishment of native shrub seedlings
  - Herbaceous species composition & production (mostly exotic)
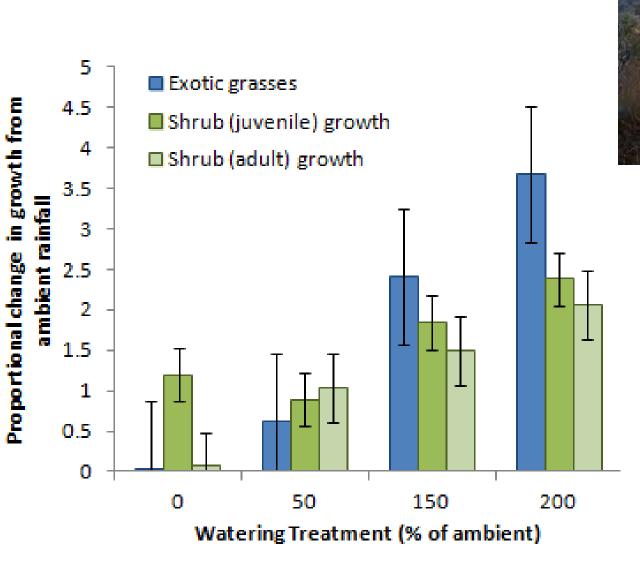  - Functional trait measures

Santa Margarita Ecological Reserve, Fallbrook

# Trade off: Native shrubs tolerate drought, exotic species dominate in high rainfall
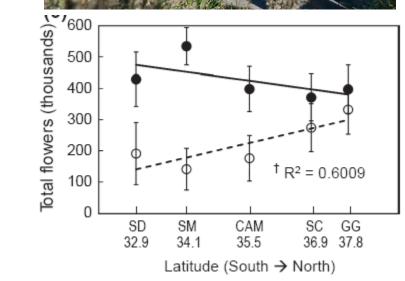


- Restoration efforts involving watering, or in wet years need to pay particular attention to exotic species control

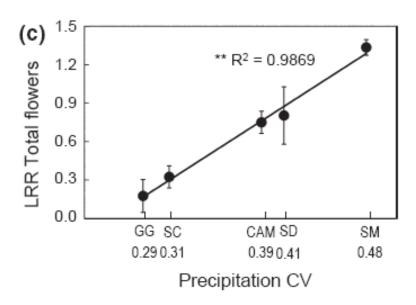- Drought years offer windows of low competition for shrub establishment

Ashbacher et al. in review

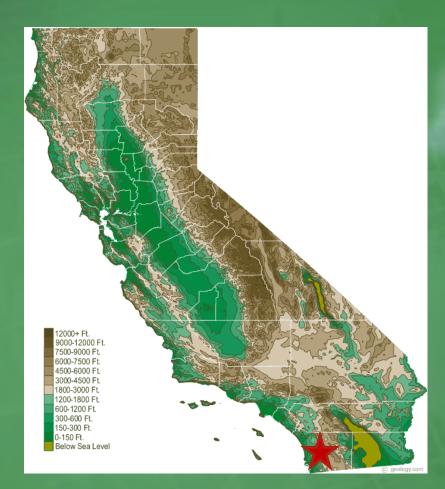# What source population to plant? Regional variation in *Artemisia californica* response to changing rainfall



-Southern populations have experienced greater variation in yearly rainfall in the past

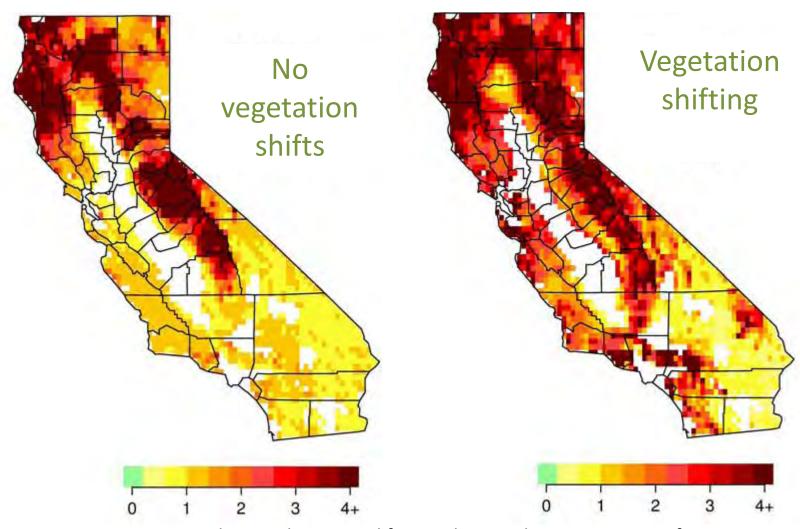-These populations respond most positively to increased watering



Pratt & Mooney 2013, Global Change Biology

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# Increasing fire frequency, positive feedbacks as vegetation responds to climate change



No vegetation shifts

Vegetation shifting

Westerling et al 2009, California Climate Change Center Draft Report
"Climate change, growth, and California wildfire"

# Fire has direct effects on biota, promotes exotic invasion of CSS

-Traditional fire-return intervals are hard to discern for CSS

- 20 years for Venturan CSS (Minnich & O'Leary 1986)

- 25 years in Riversidian CSS (Minnich unpub.)

- Fire regime has accelerated in many areas due to human activities, climate change, increase in exotic annual grasses due to N deposition



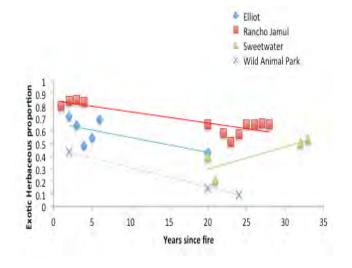Recently burned hillside in Orange County, Photo credit: Jen Funk

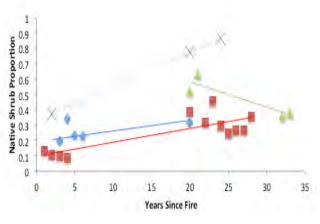# In SD county CSS, native shrub cover increases in the 20 years following fire



-Shrubs can recover following fire, even the presence of exotic species, given enough time

-Accelerating fire regimes may maintain exotic dominance

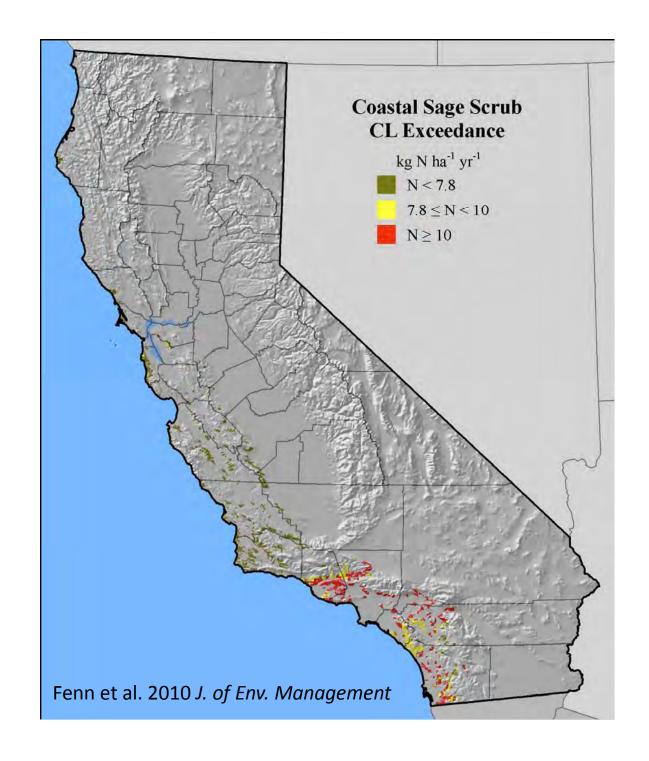-Sites with high N deposition may see slow shrub declines

Gressard 2012, Dissertation, Data from USGS

# CSS & N Deposition

-Nitrogen deposition exceeds critical loads for CSS over much of Southern California

-Many studies show that exotic annual grasses benefit more than native species from N enrichment

-Restoration practices should consider efforts to reduce N deposition (mulching), promote native species that can compete effectively with exotics

**Coastal Sage Scrub CL Exceedance**

kg N ha$^{-1}$ yr$^{-1}$

N < 7.8

$7.8 \leq N < 10$

$N \geq 10$

Fenn et al. 2010 *J. of Env. Management*

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  - Restoration in the face of invasion and environmental change – 2 case studies

- Case study: Laguna Coast Wilderness Park, Orange County CA

- Reserves at the urban-wildland interface have "edges" that are often along roads

- Invasive species, disturbance, N deposition

- Management along edges to maintain a buffer of native vegetation, to protect the interior

- Test strategies to reduce N availability and identify native species that can compete effectively with exotic species
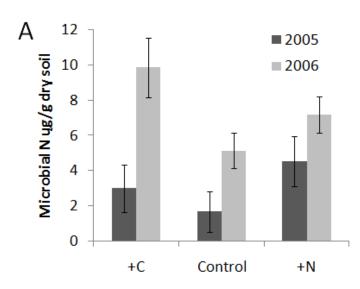
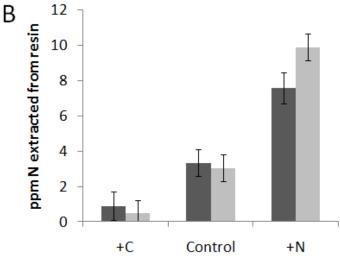# Hypothesis 1: Invasion will be reduced under lower N availability

## Three levels of Nitrogen

Ambient

+ N (9 g N/m²yr)

- N (600 g C/m²yr)

# Hypothesis 2: Native species prevent invasion by exotic species with similar functional traits

- Planted 6 seed mixes, each containing the same
20 native species, monitored invasion

-Annual grass (early)

-Early-active forb

-Perennial grass (late)
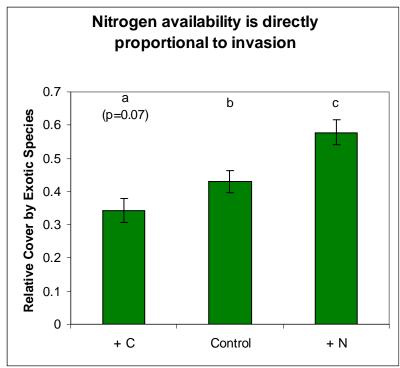
-Late-active forb

-Legume

-Even mix of all functional groups

# Lowering N availability lowered invasion

-Carbon addition strongly favored native over invasive species

-Nitrogen enrichment leads to high dominance by exotic annual grasses



+ Carbon



**Nitrogen availability is directly proportional to invasion**

a
(p=0.07)

b

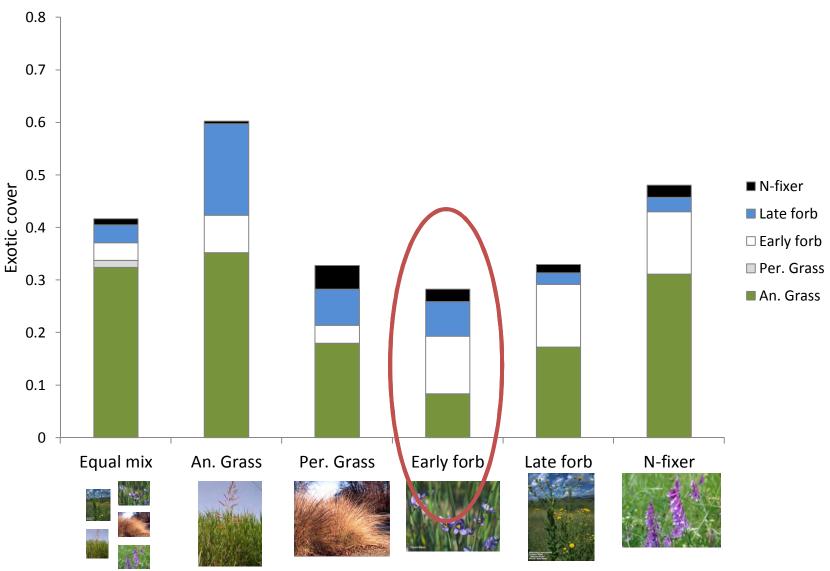c

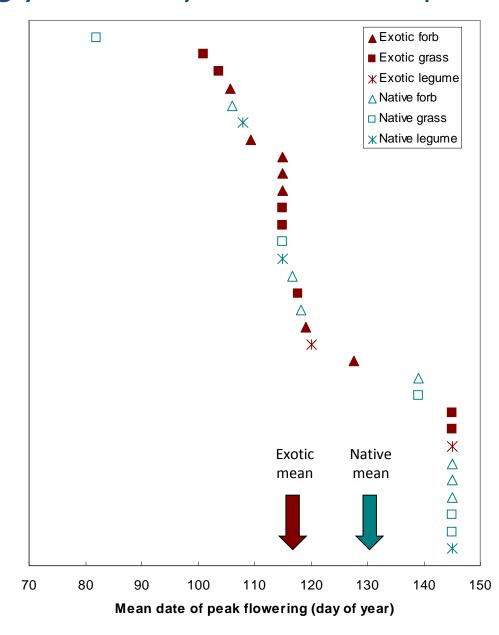Relative Cover by Exotic Species

+ C    Control    + N



+ Nitrogen

# Least cover of exotic species in plots dominated by early-active native forbs... why?



Cleland et al. 2012 *Restoration Ecology*

# Phenology – Exotic species have early phenology, compete most strongly with early-active native species

Aristida adcensionis
Bromus madritensis
Bromus diandrus
Erodium cicutarium
Lasthenia californica
Lupinus succulentus
Malva parviflora
Anagalis arvensis
Conyza floribunda
Sonchus oleraceus
Bromus hordeaceus
Vulpia myuros
Vulpia microstachys
Lupinus bicolor
Escholzia californica
Lolium perene
Phacelia cicutaria
Raphanus sativus
Medicago polymorpha
Brassica nigra
Hemizonia fasciculatum
Nasella pulcrha
Avena fatua
Lolium multiflorum
Vicia dasycarpa
Clarkia purpurea
Eriophylum confertiflorum
Sisyrinchium bellum
Bromus carinatus
Nasella lepida
Lotus purshianus

Legend:
▲ Exotic forb
■ Exotic grass
✳ Exotic legume
△ Native forb
☐ Native grass
✳ Native legume

Exotic mean
Native mean

**Mean date of peak flowering (day of year)**
70    80    90    100    110    120    130    140    150

# Conclusion: Restoration through altered timing?

- Plant native species that have overlapping phenology with problematic invaders

- What allows exotic species to be active early in the growing season?

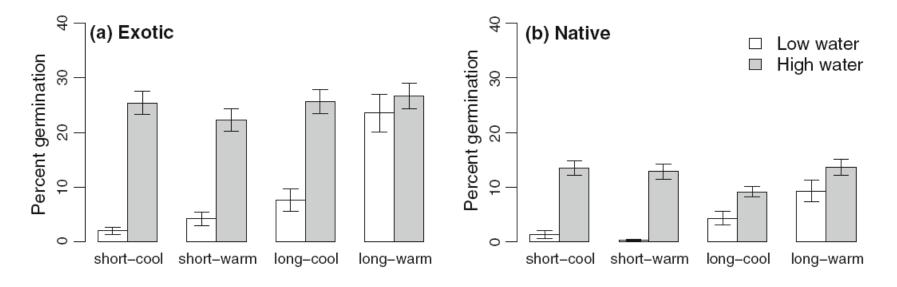- Can we exploit this early phenology in restoration strategies?

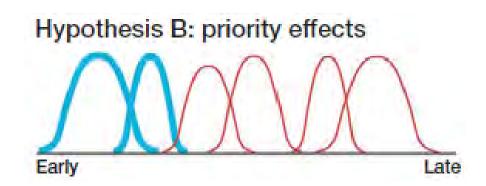# Exotic annual grasses have early phenology due to flexible germination cues

- ## Growth chamber study
  - 12 native spp, 12 exotic spp
  - Cues: soil moisture, daylength, temperature
  - Exotic species were better able to maximize germination under favorable growing conditions



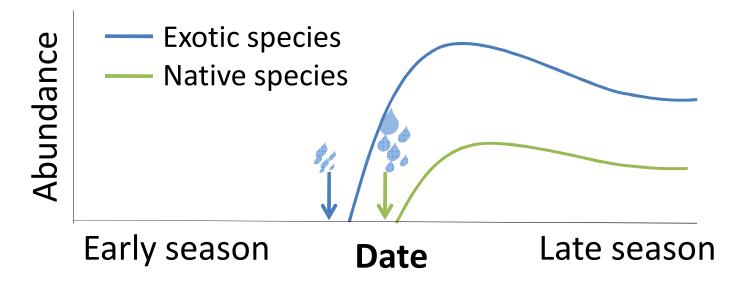Wainwright & Cleland 2013 *Biological Invasions*

# Benefits and costs of early phenology

- Exotic species could benefit from seasonal priority effects
  - germinate earlier, preempt resources, competitively dominant



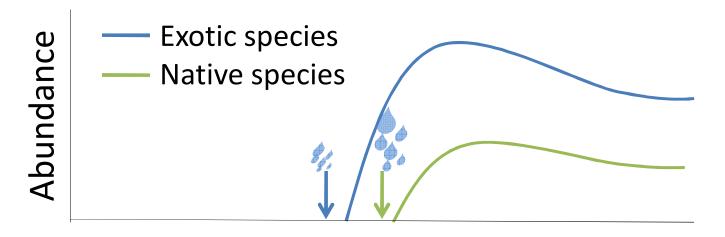Hypothesis B: priority effects

Early     Late

- Costs of early phenology
  - Risk of missing the true start of the growing season
  - Apparency to herbivores
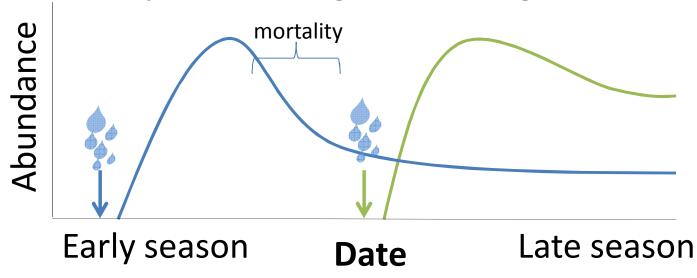


www.naturfoto.cz     © Jiří Bohdal

Hyp 1: Priority advantage: flexible germination cues

Hyp 1: Priority advantage: flexible germination cues

Hyp 2: Priority disadvantage: mistiming

Exotic species
Native species

Abundance

mortality

Early season    Date    Late season
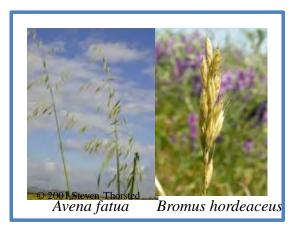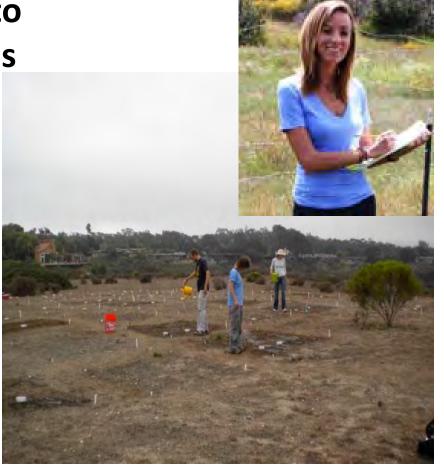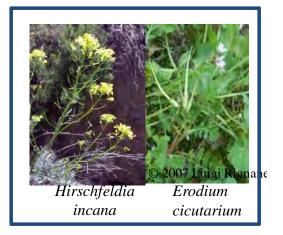
# Case study 2: Timed watering to favor native over exotic species

- UC Scripps Coastal Reserve

- Compared plots with late-summer watering to unwatered controls (winter rains only)

- Focal native & exotic species were seeded into each plot, in addition to existing seedbank

- Monitored germination and survivorship



*Avena fatua*    *Bromus hordeaceus*

*Artemisia californica*    *Encelia californica*    *Deinandra fasciculata*

*Hirschfeldia incana*    *Erodium cicutarium*

## A. Winter Rains, priority advantage

Mean # individuals/0.01m²

— Native
— Exotic annual grasses
— Exotic annual forbs

A. Winter Rains, priority advantage

B. Summer watering, priority disadvantage

Native
Exotic annual grasses
Exotic annual forbs

Date

Wainwright *et al* 2012 *J. Applied Ecology*
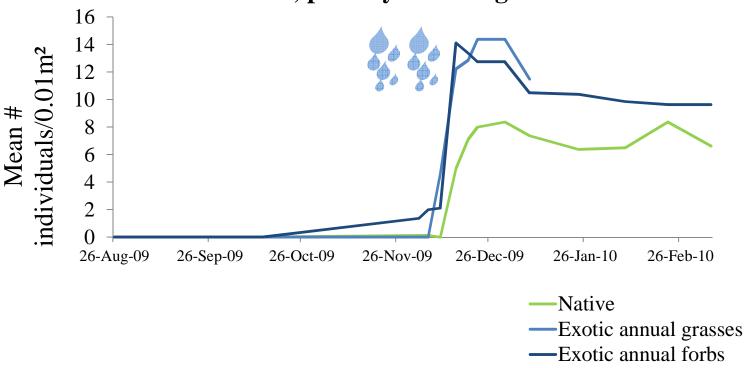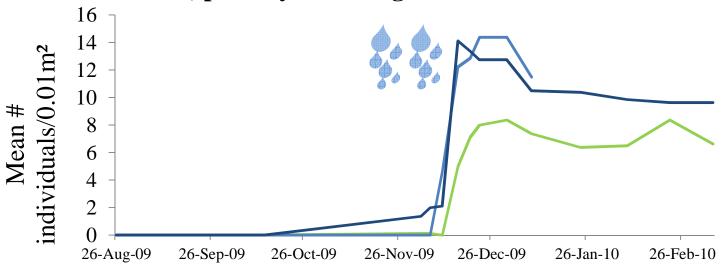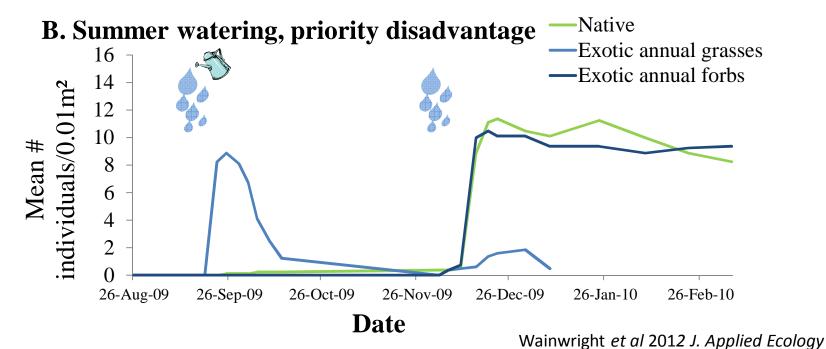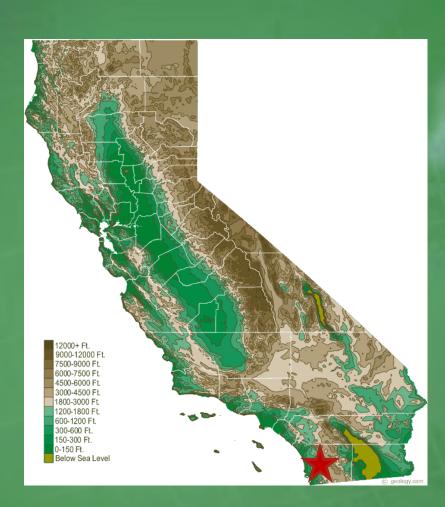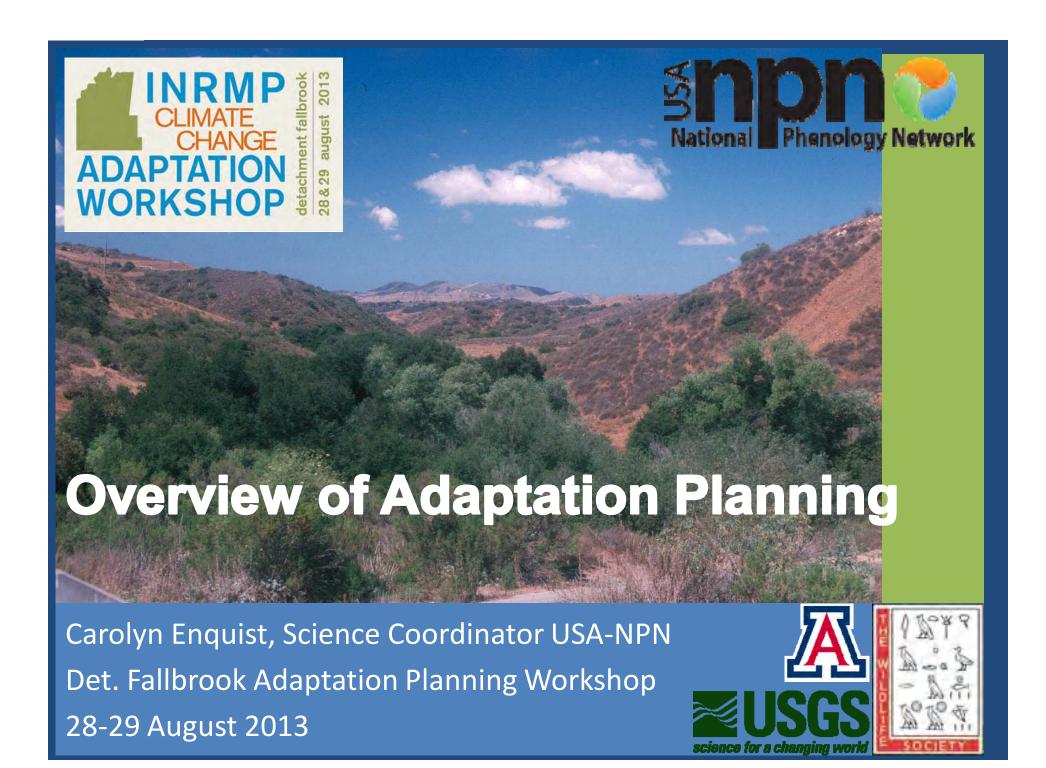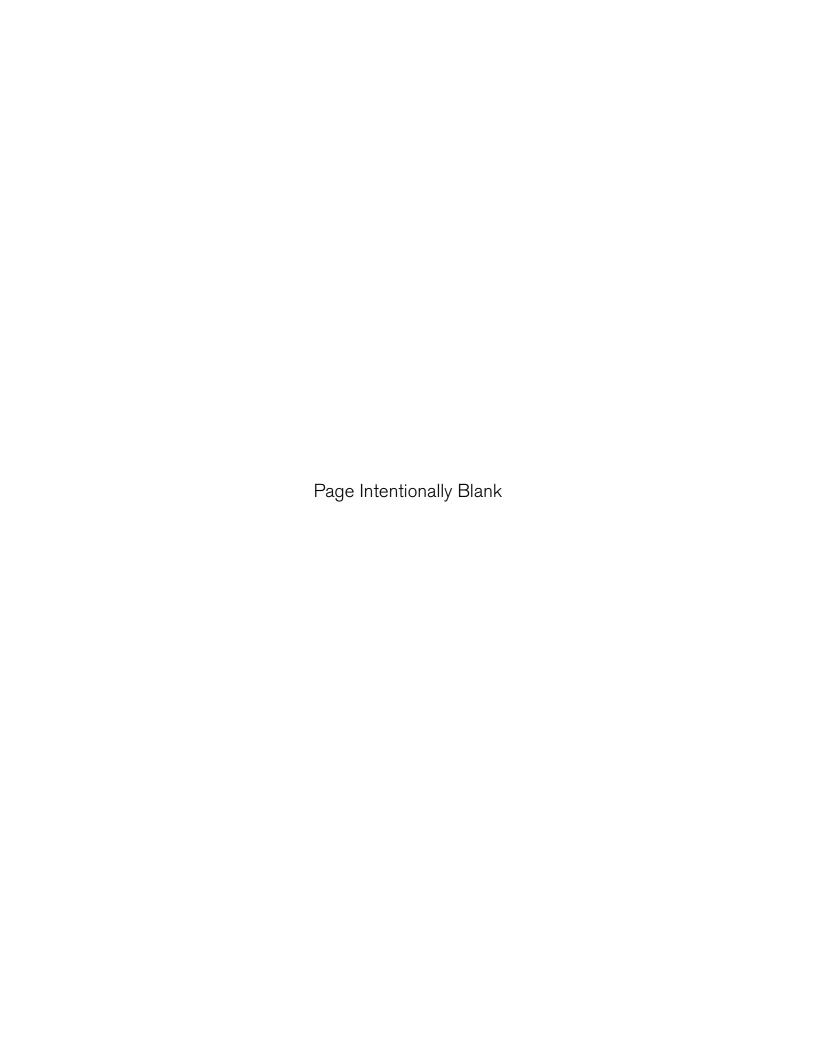
## Conclusions

- SDMs provide an important starting point for predicting species at risk for declines with climate change

- Lots of variability... success is likely based on monitoring populations & evaluating strategies prior to implementation

- Strategies for restoration & adaptation to climate change need to consider other interacting environmental factors
  - Shifting habitat, species interactions
  - Invasive species
  - N deposition
  - Fire regimes

- Opportunities for creative & effective conservation of sensitive species and habitat



12000+ Ft.
9000-12000 Ft.
7500-9000 Ft.
6000-7500 Ft.
4500-6000 Ft.
3000-4500 Ft.
1800-3000 Ft.
1200-1800 Ft.
600-1200 Ft.
300-600 Ft.
150-300 Ft.
0-150 Ft.
Below Sea Level

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# Overview of Adaptation Planning

Carolyn Enquist, Science Coordinator USA-NPN

Det. Fallbrook Adaptation Planning Workshop

28-29 August 2013

# Talk outline

1. **What is Climate Adaptation?**
   1. *General principles*
   2. *Aligning with management goals*

2. **Adaptation Planning**
   1. *Frameworks*
   2. *An example from Yellowstone*
   3. *In the context of INRMPs & Det. Fallbrook*

3. **Objectives of breakout groups**

# Climate adaptation

**Actions that enable species, ecosystems— and humans—better cope with or adjust to changing conditions.**

Courtesy of Dawn Lawson

© TNC

Courtesy of Dawn Lawson
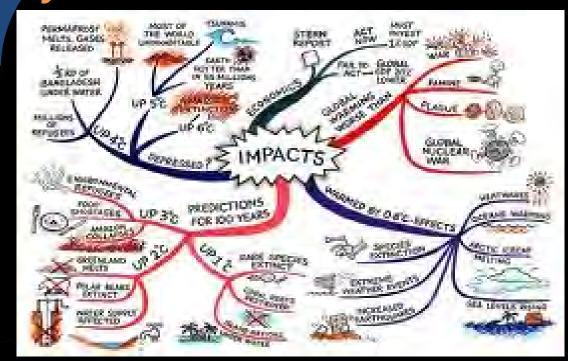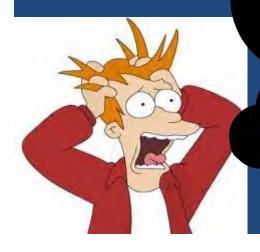
# Climate adaptation

## Conceptually challenging
*High Uncertainty*



*High Complexity*

# General principles



- **Reduce non-climate stressors**

- **Manage for ecological function and biodiversity**

- **Establish buffer zones and connectivity**

- **Increase monitoring & facilitate management under uncertainty**

- **Implement "proactive" strategies**

Adapted from "Adaptation 2009" discussion paper by Glick et al. and other sources

# Aligning management goals
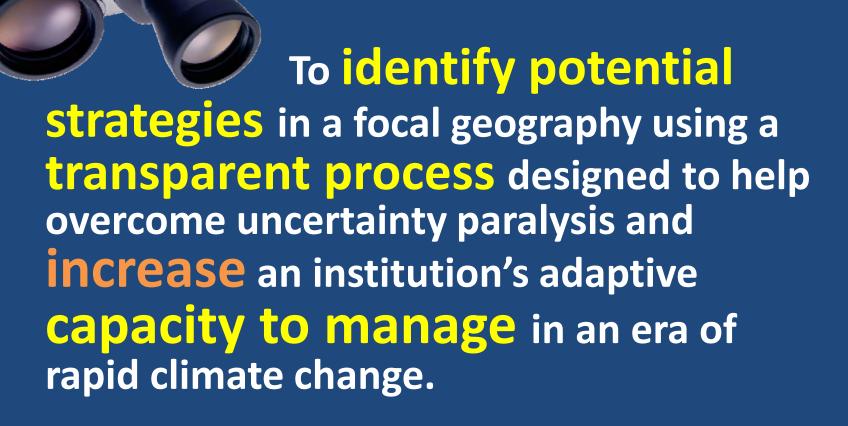
*What are they trying to achieve?*

- Increase **RESISTANCE** to change?

- Promote **RESILIENCE** to change?

- To enable ecosystems to **RESPOND** to change? *(sometimes called facilitation)*

- To help determine when to consider **TRIAGE?**
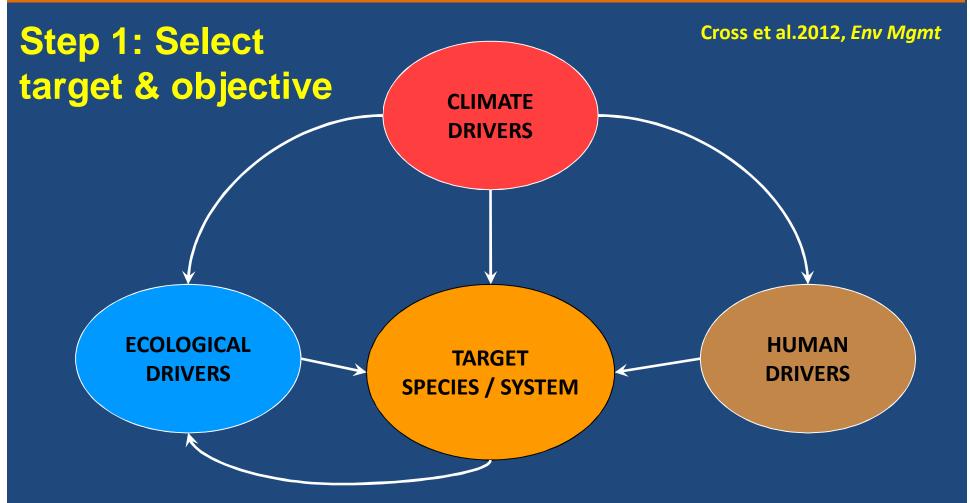
Adapted from Millar et al. 2007, Ecological Applications and USFS Climate Change Resource Center

# Goal of adaptation planning

To **identify potential strategies** in a focal geography using a **transparent process** designed to help overcome uncertainty paralysis and **increase** an institution's adaptive **capacity to manage** in an era of rapid climate change.
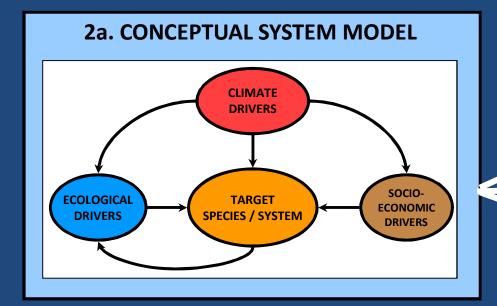
# An adaptation framework

THE ACT FRAMEWORK

Adaptation planning phase

Implementation & efficacy evaluation phase

1. Select conservation target and Define management objective

2. Assess climate change effects

Build conceptual model

Assess Responses to scenarios

Identify future climate scenarios

Repeat for:
• more targets
• more objectives
• more information

3. Identify intervention points and management actions

4. Prioritize actions & develop plan

6. Monitor and evaluate action plan efficacy

6.5 Adjust actions as needed

5. Implement priority actions

Cross et al. 2012, Env Mangmnt

# An example



**Yellowstone River flows (ecological process)**

## Step 1: select target & objective
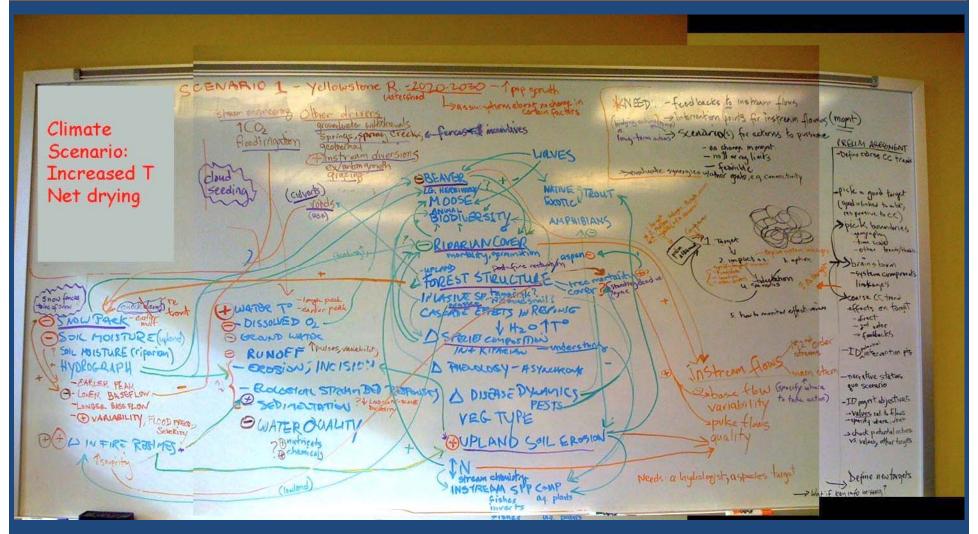
**To maintain Yellowstone cutthroat trout**

# An example

# An example



forest management → wildfire

forest management → upland forest type/structure

agricultural practices → flood plain condition

agricultural practices → withdrawals (agri., urban)

urban growth → withdrawals (agri., urban)

urban growth → impervious surfaces

flood plain condition → **Yellowstone River flows** *quantity, temperature, timing*

upland forest type/structure → Yellowstone River flows

temperature + precipitation → wildfire

temperature + precipitation → upland forest type/structure

temperature + precipitation → Yellowstone River flows

temperature + precipitation → snowpack

temperature + precipitation → groundwater

snowpack → Yellowstone River flows

snowpack → groundwater

groundwater → Yellowstone River flows

impervious surfaces → Yellowstone River flows

beaver → riparian cover

riparian cover → Yellowstone River flows

grazing practices → riparian cover

riparian cover → Yellowstone River flows

**Step 2: Build conceptual model**

# An example

USA **npn** National Phenology Network

forest management

wildfire

Δ

upland forest type/structure

?

warmer & drier climate

+

Δ

−

agricultural practices

flood plain condition

withdrawals (agri., urban)

urban growth

**Flows:
Lower base flows
Warmer water temps
Earlier spring peak**

impervious surfaces

−

−

snowpack

?

-?

groundwater

−

-?

riparian cover

beaver

grazing practices

**Step 2b. Climate
Scenario 1: Warmer-drier**

# An example

forest
**management**

wildfire

Δ

+

Δ

upland forest
type/structure

?

agricultural
practices

flood plain
condition

withdrawals
(agri., urban)

urban
growth

**warmer & drier
climate**

-

**Flows:
Lower base flows
Warmer water temps
Earlier spring peak**

impervious
surfaces

-

-

snowpack

-?

?

-?

riparian
cover

beaver

**grazing
practices**

groundwater

-

**Step 3a. Identify
intervention points**

# Step 3b. Potential actions for initial climate scenario

Intervention Points → Potential Actions → Desired Responses

| Intervention Points | Potential Actions | | Desired Responses |
|---|---|---|---|
| Snowpack management | Build snow fences | Increase local snowpack | High flows |
| High elevation streamflow | Install check dams | | |
| Beaver populations | Reintroduce beaver | Increase rain retention | Peaked hydrograph |
| Impervious surfaces | Reduce / remove roads | | |
| Grazing practices | Reduce livestock density | Increase riparian shading | Maintain appropriate water T |
| Riparian vegetation | Fence riparian areas | | |
| | Restore riparian vegetation | | |

# Context of INRMPs

- ***Compliance with*** applicable natural resource laws (including regulations)

- ***Sustainable management*** of natural resources.

- ***Sustainable use by the public*** of resources subject to mission compatibility, safety & security

- **NO NET LOSS** *in the capability of installation lands to support the military mission*
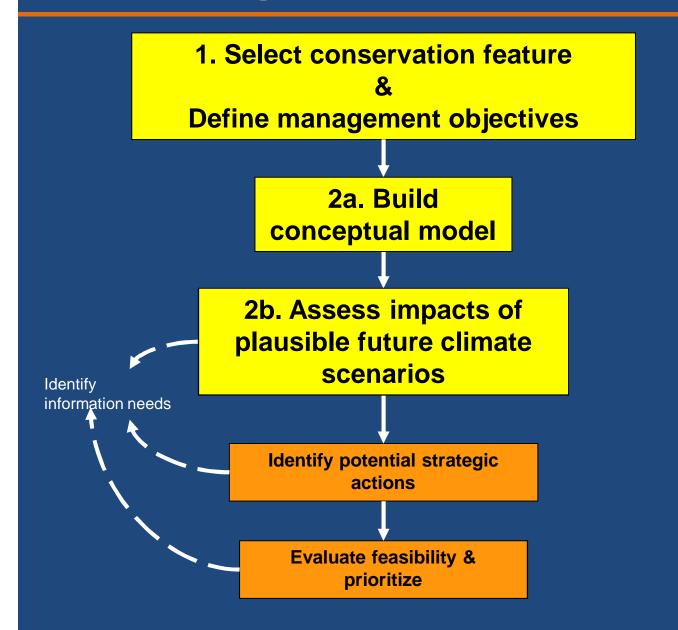
# Detachment Fallbrook



Coastal Sage scrub

U.S. Navy photo by MC1 Eli J. Medellin

# Targets for this workshop

1. Coastal sage scrub



2. Riparian

# Breakout groups

1. Select conservation feature
&
Define management objectives

↓

2a. Build conceptual model

↓

2b. Assess impacts of plausible future climate scenarios

Identify information needs

↓

Identify potential strategic actions

↓

Evaluate feasibility & prioritize

Day One objectives

Day Two objectives

## Towards strategic "climate-informed" monitoring as a key adaptation action

Photo by Christy Wolf
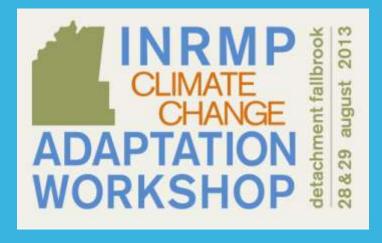
*"Adapt, improvise, and overcome."*
— T.C. Cummings, *Mind of a SEAL*
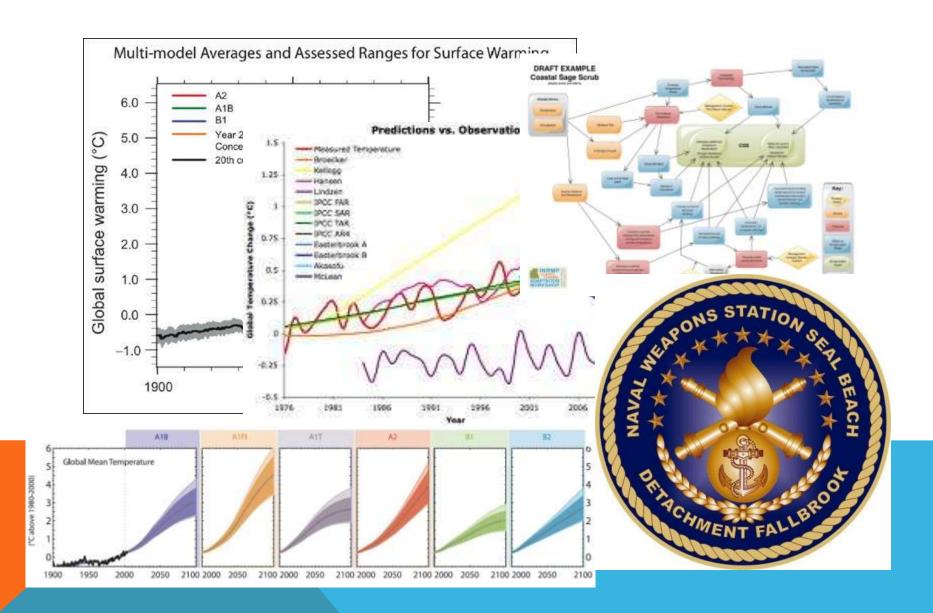
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# HOW ARE WE TO PROCEED???

# LUNCH!!!

# LUNCH.

# BREAK INTO GROUPS

| Time | Topic | Group Facilitators |
|------|-------|--------------------|
| 12:30-16:00 | Group 1: Coastal Sage Scrub | Robert Wolf & Brenna Vredeveld |
| 12:30-16:00 | Group 2: Riparian Woodland | Bill Wild & Anna Kellogg |

# DAY 1, STEP 1 & 2

1. What is our targeted conservation feature?



Coastal Sage Scrub



Riparian Woodlands

2. Review the current INRMP management objectives for CSS or Riparian.

# DAY 1, STEP 3

Conceptual model review, revision.

# DAY 1, STEP 4

Use the conceptual model as a guide to filling in the blanks in Table 1.

Table 1: Primary reference for linking Climate Change with our hypotheses of ecological change

Identify Key Driver  - How does the driver manifests under different scenarios ? – What is our hypothesis of ecological change on our conservation target?

Finally – what monitoring activities are relevant to the ecological hypotheses we come up with?

# DAY 1, STEP 5

Let it sink in.



Sleep on it.

# DAY 2, ALL MORNING

Day two is all Management Focused.

Start with our Hypotheses of Change from Table 1. and  use it to begin Table 2.

This will allow us think systematically about how we monitor (Drivers and Pressures as well as our hypothesized effects).

Management under different scenarios.

The priorities of our proposed interventions.

Opportunities for implementation.

Re-evaluation of management objectives.

# DAY 2, AFTERNOON – REVIEW AND SYNTHESIS

Part 1. You present your work!

Identify your strategic actions, and their rank.

General thoughts, considerations, concerns regarding management actions.

Part 2. Facilitated discussion by Carolyn Enquist.

What barriers might exist for implementing strategic actions?

How to overcome them?

Installation versus regional action?

# NEXT STEPS AND WRAP-UP

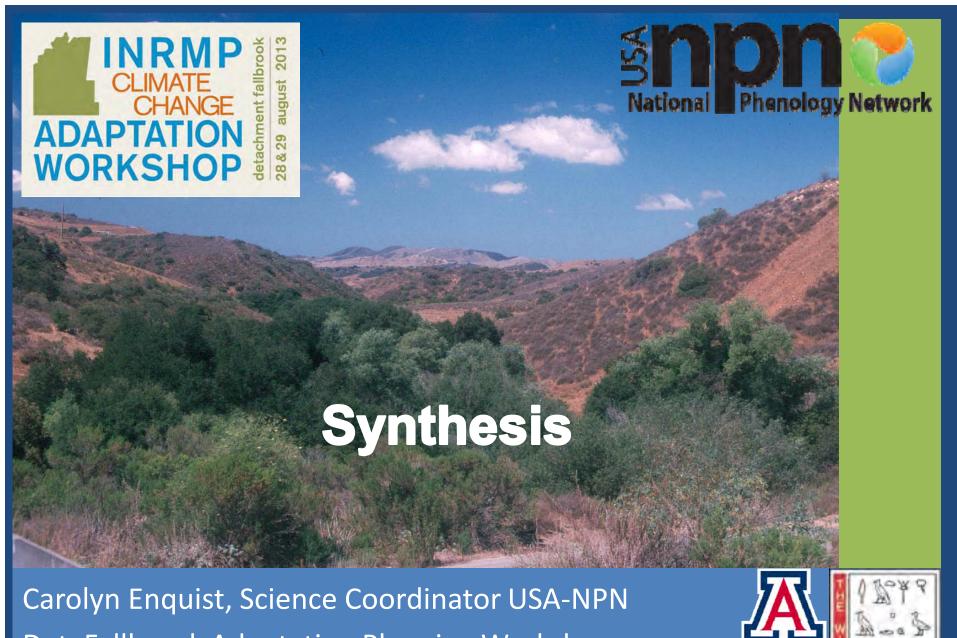If monitoring is so important, how are going to set the stage to implement it? – Carolyn Enquist

Workshop Summary and what are going to do with all this information? – Dawn Lawson

Goodbye. ☹ - Christy Wolf.
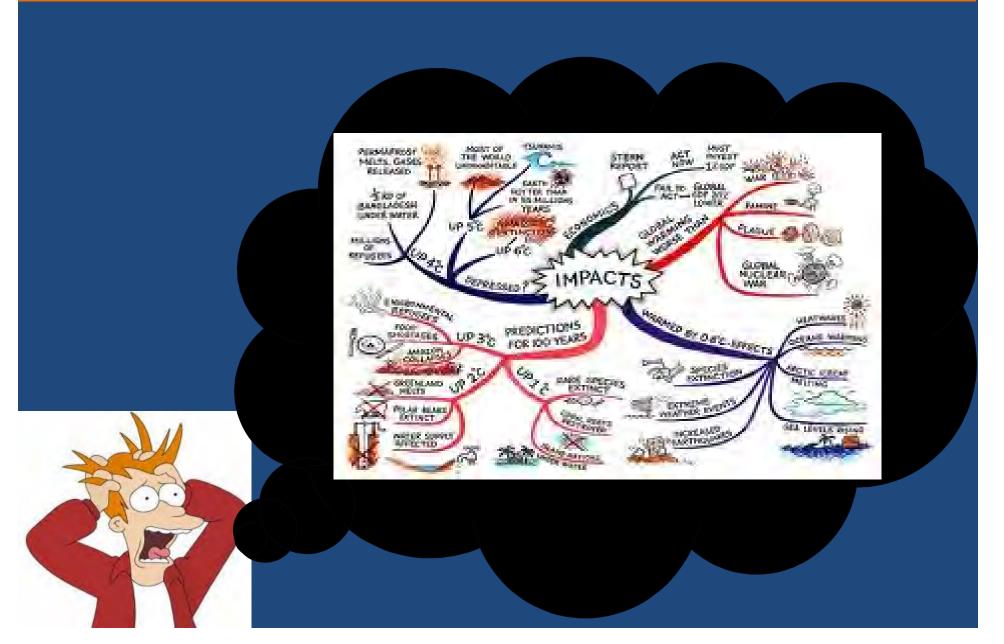
# LETS EAT!

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# Synthesis

Carolyn Enquist, Science Coordinator USA-NPN

Det. Fallbrook Adaptation Planning Workshop

28-29 August 2013

# Climate adaptation

"*Adapt, improvise, and overcome.*"
— T.C. Cummings, *Mind of a SEAL*

# Goal of adaptation planning

To **identify potential strategies** in a focal geography using a **transparent process** designed to help overcome uncertainty paralysis and **increase** an institution's adaptive **capacity to manage** in an era of rapid climate change.

# Targets & objectives
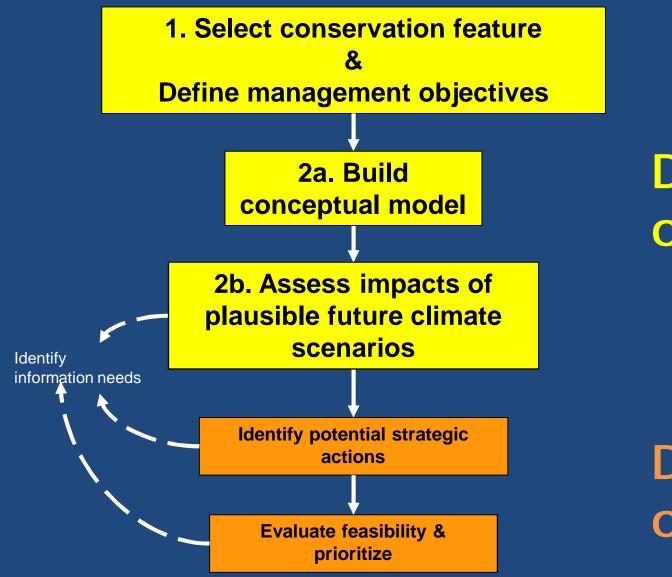
1. Coastal sage scrub: maintain habitat for gnatcatchers & SKR

2. Riparian: maintain Bell's Vireo habitat

# Step 3b. Potential actions for initial climate scenario

Intervention Points → Potential Actions → Desired Responses

**Intervention Points:**
- Riparian management
- Fire management
- Exotic spp management
- Grazing

**Potential Actions:**
- Conduct & Implement Fluvial & veg risk assessment
- Exclusion fencing, shading
- Implement eradication tools
- Targeted herbicide treatments
- Prevention & suppression measures
- Reduce biomass of annual exotics
- Restoration, Identify infrastructure Improvement, repair, reduce channelization
- Reduce competition & habitat degradation;
- Retain and maximize water in system
- Balance needs of SKR & gnatcatcher

**Desired Responses:**
- Maximize water availability
- Improve Suitable habitat;
- buffer neg effects fm fire
- Protection of Refugia & seed sources

# Discussion



*How would you describe priority actions?*

- **RESISTANCE**
- **RESILIENCE**
- **RESPONSE** or facilitation
- RE-ALIGNMENT
- *TRIAGE?*

Adapted from Millar et al. 2007, Ecological Applications and USFS Climate Change Resource Center

# Context of INRMPs

- *Compliance with* applicable natural resource laws (including regulations)

- *Sustainable management* of natural resources.

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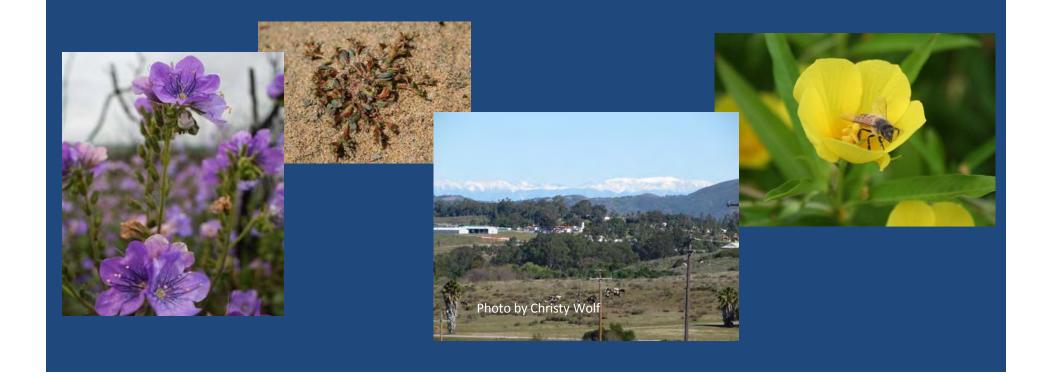
## Detachment Fallbrook

- ***Barriers to implementation?***

- ***Opportunities?***
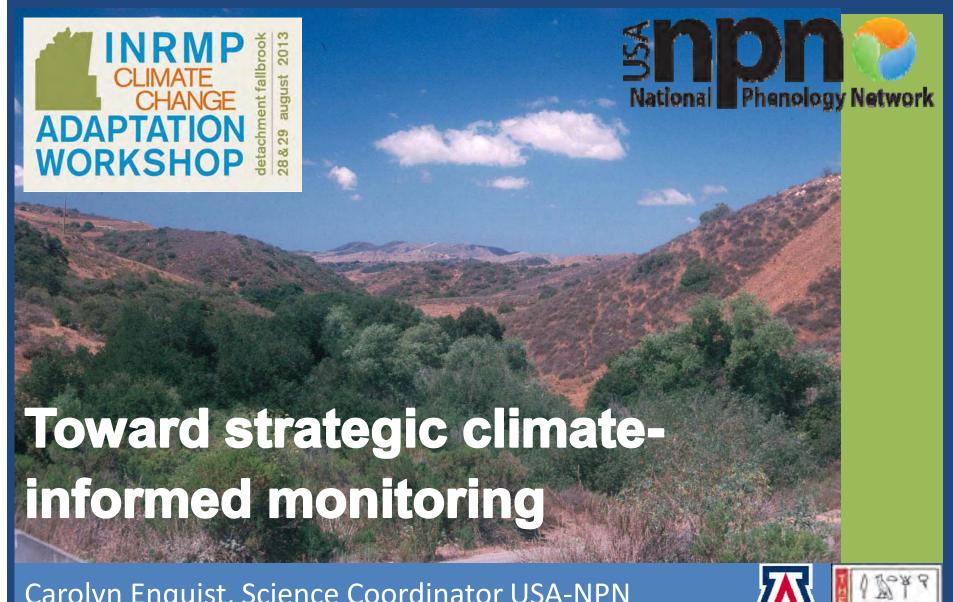
## Towards strategic "climate-informed" monitoring as a key adaptation action



Photo by Christy Wolf

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# C-I monitoring?

C-I (or climate-smart) monitoring helps provide context for understanding **climate-related impacts** and **vulnerabilities** and **for informing agile adaptive management**.

Monitoring approaches should be carefully designed to ensure they are **capable of guiding needed adjustments in strategies and actions➔evaluation**.

--Stein et al. *"ClimateSmart Conservation Quick Guide"* (full document in prep.)

# What to monitor?

**Essential Biodiversity Variables (EBVs)—Pereira et al. 2013, *Science***

| EBV CLASS | EBV EXAMPLES |
| --- | --- |
| (1) Genetic composition | Allelic diversity, phenotypes |
| (2) Species populations | Abundance & distribution |
| (3) Species traits | Phenology |
| (4) Composition | Taxonomic diversity, functional types |
| (5) Ecosystem structure | Habitat structure |
| (6) Ecosystem function | Ecosystem processes |

# Other considerations

**Motivation**
- *Status & trends (discovery)*
- *Question driven (evidence)*
- *Indicators of change*
- *Funding*

**Design:**
- *Timing, Frequency*
- *Co-location of weather stations, soil moisture, another biodiversity metric?*

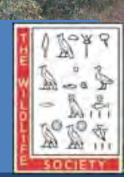**Data Management & Analysis:**
- *Storage*
- *Analysis*

# Observed shifts in the SW region

- Shift in timing of flowering
  *(Bowers 2007, Inouye 2008, Kimball et al. 2009, Crimmins et al. 2011)*

- Timing of migratory bird arrivals
  *(McKinney et al. 2012, Kellermann in prep)*

- Timing of animal emergence
  *(Inouye et al. 2000, Forister & Shapiro 2003, Ozgul et al. 2010)*

- Timing of egg laying
  *(Brown et al. 1999)*

# What to monitor?

**Essential Biodiversity Variables (EBVs)—Pereira et al. 2013, *Science***

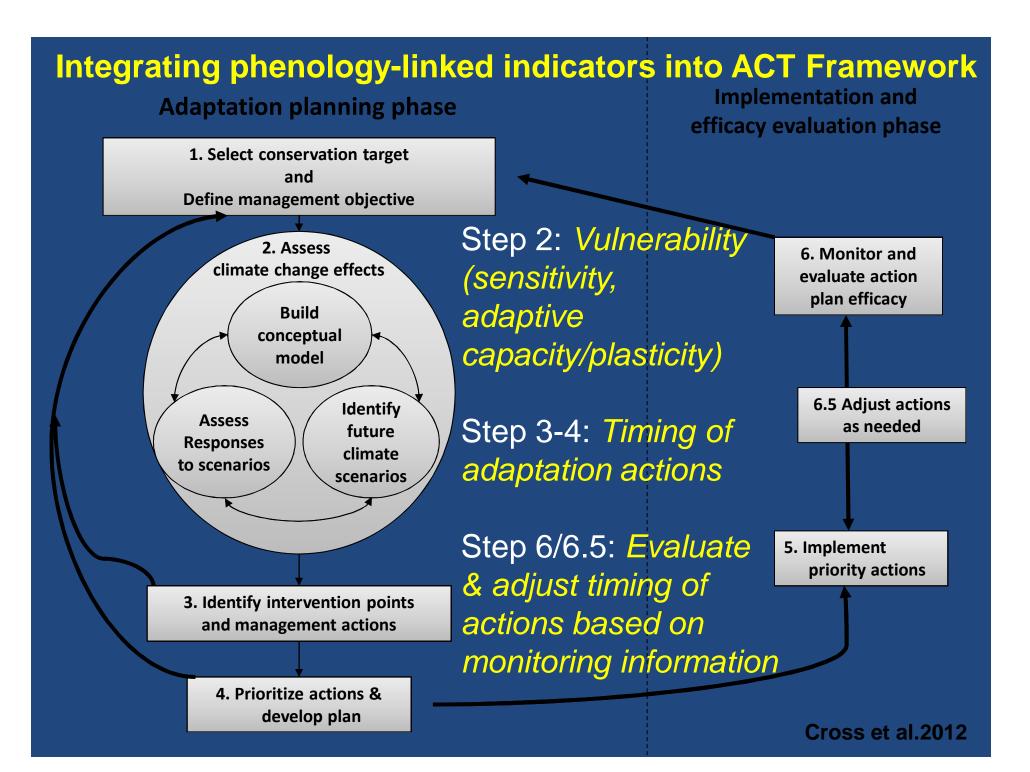| EBV CLASS | EBV EXAMPLES |
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| (5) Ecosystem structure | Habitat structure |
| (6) Ecosystem function | Ecosystem processes |

**Key indicator of climate change impacts on ecosystems:**

*"Phenology...is perhaps the simplest process in which to track changes in the ecology of species in response to climate change."*
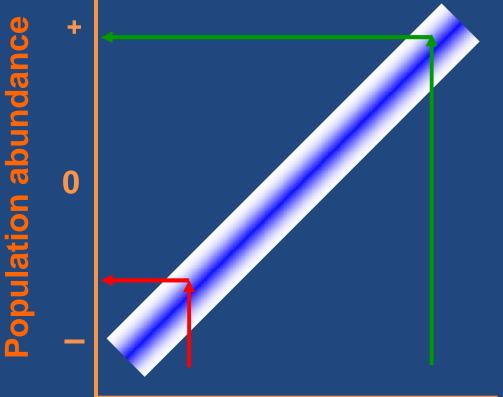
*(IPCC 2007)*

Integrating phenology-linked indicators into ACT Framework

Adaptation planning phase

Implementation and efficacy evaluation phase

1. Select conservation target and Define management objective

2. Assess climate change effects

Build conceptual model

Assess Responses to scenarios

Identify future climate scenarios

Step 2: *Vulnerability (sensitivity, adaptive capacity/plasticity)*

Step 3-4: *Timing of adaptation actions*

Step 6/6.5: *Evaluate & adjust timing of actions based on monitoring information*

6. Monitor and evaluate action plan efficacy

6.5 Adjust actions as needed

5. Implement priority actions

3. Identify intervention points and management actions

4. Prioritize actions & develop plan

Cross et al.2012
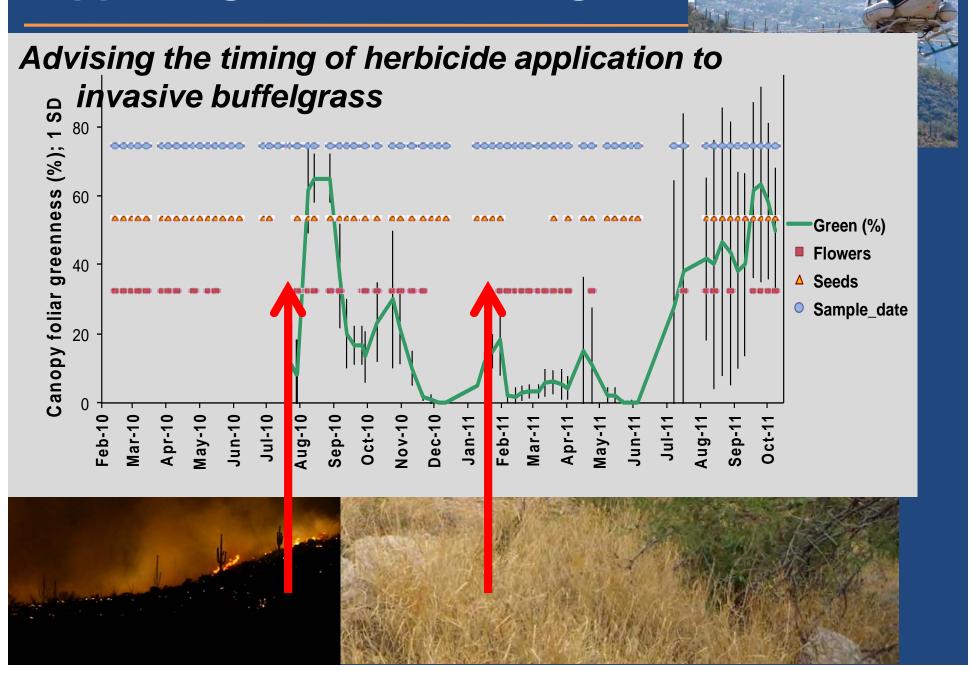
# Applications

## Shifts in the Timing of Management Actions

# Supporting decision-making

**Advising the timing of herbicide application to invasive buffelgrass**

# Toward a framework for strategic climate-informed monitoring for INRMPs....

*Can we come up with a shared vision?*

# Other considerations



**Motivation**
- *Status & trends*
- *Question driven*
- *Funding*

**Design:**
- *Timing*
- *Frequency*
- *Co-location of weather stations, soil moisture, another biodiversity metric?*

**Data Management & Analysis:**
- *Storage*
- *Analysis*